REMARKS

Claim 15 is objected to as being dependent upon a rejected base claim, but would be allowed if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Claim 15 is now rewritten in independent form, and allowance thereof is respectfully requested.

Claims 1-6, 8, 10-14, and 16-17 stand rejected for obviousness under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 5,595,670 ('670) to Mombo-Caristan in view of JP 60-148670 ('670). Claim 7 stands rejected for obviousness under 35 U.S.C. §103(a) over Mombo-Caristan '670 and JP '670 and further in view of U.S. Patent No. 6,410,882 to Okada. Claim 9 stands rejected for obviousness under 35 U.S.C. §103(a) over Mombo-Caristan '670 and JP '670 and further in view of U.S. Patent No. 5,603,853 ('853) to Mombo-Caristan.

Applicants respectfully traverse these rejections for the following reasons. The present invention relates to a method of hybrid welding including focusing a laser beam onto a joining region between a pair of metal components to form a molten pool and establishing a keyhole therein. The molten pool is a mixture of metals from each of the components. Additionally, molten metal is also discharged from an arc welding torch into the molten pool formed from the laser beam. By translating the focused beam along the joining region in a first direction and oscillating the beam relative to the molten pool at a direction different from the first direction, the keyhole is continuously moved and immediately refilled by the pool of molten metal, which includes the metals from each component and the metal discharged from the arc welding torch. Welding takes place as the keyhole penetrates through the molten pool and melts the components being welded at the interface therebetween. In the vicinity of the focused laser beam, the molten pool is vaporized to produce a keyhole which is translated with the oscillating beam. As the beam oscillates in a direction different from the first direction (e.g., transverse to the first direction), the keyhole oscillates through the pool of molten metal and molten metal fills into the keyhole as the keyhole oscillates. In this manner, the keyhole continuously is produced and then is refilled with molten metal that solidifies to produce a weld. The method defines a laser-based hybrid welding process, in that arc welding is combined with the laser welding.

The Mombo-Caristan '670 patent serves as the basis for each of the prior art rejections. The Mombo-Caristan '670 patent discloses laser beam welding using a beam spot that may be oscillated back and forth about an axis of the beam spot as shown in Fig. 11. As acknowledged in the Office Action, Mombo-Caristan '670 does not teach discharging molten metal by arc welding, as required by the claims of the present invention.

The JP '670 patent discloses a plasma arc welding method that includes irradiating a laser beam on the front surface of the keyhole produced by the arc welder in the thickness direction. Vertical oscillation of a laser oscillator irradiates the part in the thickness direction of the front surface of the keyhole. The welding is performed, however, by plasma arc welding. The oscillating laser only ensures that the thickness of metal being welded is fully treated, and is not affecting laser welding. The teaching of using a laser to vertically irradiate the advancing keyhole front produced by arc welding does not suggest discharging an arc welding torch into the keyhole produced by a laser beam welding process. Quite simply, Mombo-Caristan '670 relates to laser beam welding. The JP '670 patent relates to arc welding. Nothing in either JP '670 or Mombo-Caristan '670 suggests that the laser beam welding method of Mombo-Caristan '670 would benefit from discharging an arc welding torch into the laser beam keyhole. Likewise, nothing in Mombo-Caristan '670 would suggest that the plasma arc welding torch of JP '670 should be used with laser beam welding.

There is no motivation to modify the teachings of Mombo-Caristan '670 to include discharging metal from an arc welding torch. The teaching in JP '670 to vertical laser irradiate a keyhole front produced by arc welding does not suggest oscillating a laser beam through a keyhole produced from laser beam welding. The JP '670 patent teaches that keyhole front irradiation during arc welding improves weld speed and penetration. This does not suggest the reverse, of discharging metal from an arc welding torch to affect a laser beam weld. Therefore, claims 1-6, 8, 10-14, and 16-17 define thereover.

The rejection of claim 7 is based on additional teachings of the Okada patent regarding the laser oscillation frequency. The Okada patent does not account for the deficiencies of the Mombo-Caristan '670 patent and the JP '670 patent. Hence, claim 7 is

believed to define over the prior art of record for at least the same reasons as claims 1-6, 8, 10-14, and 16-17.

The rejection of claim 9 relies on the teachings of the Mombo-Caristan '670 patent and the JP'670 patent and further in view of the Mombo-Caristan '853 patent. Again, the Mombo-Caristan '853 patent does not account for the deficiencies of the Mombo-Caristan '670 patent and the JP '670 patent. Therefore, claim 9 is believed to define over the prior art of record. In addition, the Mombo-Caristan '853 patent teaches the use of fill-in material to weld a larger gap, i.e., about 0.1 mm wide. The present invention does not require such a filler material in view of the oscillating laser beam spot.

In view of the amendment to claim 15, all the claims are believed to define over the prior art of record and to be in condition for allowance.

Respectfully submitted,

THE WEBB LAW FIRM

By _____

Kirk M. Miles
Registration No. 37,891
Attorney for Applicants
436 Seventh Avenue
700 Koppers Building
Pittsburgh, PA 15219-1818
Telephone: (412) 471-8815
Facsimile: (412) 471-4094
E-mail: webblaw@webblaw.com